J. David Moulton

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Education

B.Eng.	Physics, McMaster University, *summa cum laude*, 1988
M.Eng.	Physics, McMaster University, 1990 *Thesis: Diffusion Modelling of Picosecond Pulse Propagation in Turbid Media (August 1990)*
Ph.D.	Mathematics, University of British Columbia, 1997 *Thesis: Nodal Methods: Performance, Analysis and Fast Iterative Solvers (November 1996)*

Research Experience

- **Staff Member (Limited Term)**
  October 1998 – present
  Mathematical Modeling and Analysis, Theoretical Division, Los Alamos National Laboratory
  Research: Homogenization, Mixed and Mixed-Hybrid FEMs, parallel computing, Krylov subspace and multigrid solvers.

- **Postdoctoral Research Associate**
  November 1996 – September 1998
  Center for Nonlinear Studies and T-7, Theoretical Division, Los Alamos National Laboratory
  Research: Homogenization, Mixed-Hybrid FEMs, Krylov subspace and multigrid solvers.

- **Research Assistant**
  September 1995 – August 1996
  Institute of Applied Mathematics, University of British Columbia
  Research: Mixed FEM discretization of elliptic PDEs with highly discontinuous coefficients.

- **Student Visitor**
  October 1994, March 1995
  T-7, Theoretical Division, Los Alamos National Laboratory
  Research: Multigrid and Krylov subspace iterative solution of Nodal Methods.

Research Interests

- Discretization techniques for partial differential equations, particularly elliptic equations with discontinuous coefficients. The methods of interest include mixed and mixed-hybrid finite elements, nodal, finite volume and most recently, support operator discretizations.

- Iterative methods such as multigrid and multigrid preconditioning of Krylov subspace algorithms for the solution of the discrete linear systems that arise from the aforementioned discretizations. Typically these linear systems have a non-standard sparsity pattern and may be indefinite.

- The development of new, numerical, multilevel upscaling techniques that will facilitate the accurate coarse-scale numerical treatment of flow through heterogeneous porous media.
- Parallel computing, and in particular, parallel iterative solvers. Many iterative solvers have inherently serial components that make their parallelization difficult. Multilevel upscaling may provide some insight into alternative approaches.

Computing Experience

- **Numerical Analysis:** 11 years experience in programming algorithms for the numerical solution of ODEs and PDEs. Focusing on PDEs, discretization techniques include, finite difference, finite element (FE), Mixed-Hybrid FE and finite volume methods. Iterative solution techniques include preconditioned Krylov subspace methods and multigrid.
- **Programming:** Experience with many languages, including Fortran 77, Fortran 90, C, MPI, Perl, Java, matlab, Maple, TEX, LATEX.
- **System Administration:** 8 years experience in the administration and maintenance of heterogenous computer networks comprised of Unix workstations, X-terminals, and Windows NT based PCs.
- **Participant:** DOE Computational Science Workshop, Summer 1992.

Scholarships, Fellowships and Awards

09/2002	Achievement Award, Los Alamos National Laboratory *Outstanding contributions to the summer student program.*
09/1998	Achievement Award, Los Alamos National Laboratory *Designing and building the Beowulf class supercomputer "Avalon".*
10/1997	High Performance Computing Fellowship, Los Alamos National Laboratory
10/1996	High Performance Computing Fellowship, Los Alamos National Laboratory
09/1993	Graduate Fellowship, University of British Columbia
09/1992	Graduate Fellowship, University of British Columbia
09/1991	Postgraduate Fellowship, Natural Sciences and Engineering Research Council of Canada
09/1991	Graduate Fellowship Supplement, University of British Columbia
09/1990	Postgraduate Fellowship, Natural Sciences and Engineering Research Council of Canada
09/1990	Graduate Fellowship Supplement, University of British Columbia
09/1989	Ontario Graduate Scholarship
09/1988	Centennial Graduate Scholarship, McMaster University
05/1988	Harold Johns' Medical Physics Student Fellowship
05/1987	Undergraduate Research Award, Natural Sciences and Engineering Research Council of Canada
09/1984	Chancellors' Admission Scholarship, McMaster University

Academic Activities

- **Organizer:** *Setting up and Using a Small Linux Cluster*, Short course at the SIAM Annual Meeting, Town and Country Resort, San Diego, CA, July 9–13, 2001.
- **Co-organizer:** *Third Annual ASCI Tri-Lab Workshop on Solvers*, Los Alamos Inn, Los Alamos, NM, December 1–2, 1999.
- **Co-organizer:** *Multiscale Modeling and Simulation of Flow and Transport in Porous Media*, University of New Mexico, Los Alamos Campus, Los Alamos, NM, August 11–13, 1999.
- **Organizer:** *Volume Averaging Methods in Porous Media – Short Course*, Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, NM, July 6–10, 1998.
  Instructor: Dr. Stephen Whitaker of UC Davis,
- **Organizer:** *Influence and Treatment of Multiple Scales in Modeling Heterogenous Media*, Minisymposium, SIAM Annual Meeting, Stanford University, CA, July 14-18, 1997.
- **Referee:** SIAM J. Num. Anal., SIAM J. Sci. Comp. and J. Comp. Phys.
- **Member:** Society of Industrial and Applied Mathematics, American Mathematical Society

Selected Presentations

[1] *New results in multilevel upscaling or homogenization*. SIAM Annual Meeting/First Joint meeting of CAIMS and SIAM, Fairmont The Queen Elizabeth Hotel, Montreal, QC, June 16–20, 2003.

[2] *A comparison of mimetic and variational preconditioners for mixed-hybrid discretizations of the diffusion equation*. Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO, March 30 – April 4, 2003.

[3] *A comparison of mimetic and variational preconditioners for mixed and mixed-hybrid discretizations*. SIAM Conference on Mathematical and Computational Issues in the Geosciences, Radisson Hotel and Suites Austin, Austin, TX, March 17–20, 2003.

[4] *A practical guide to building and using beowulf (commodity) clusters*. Half-day workshop at the 2001 ASME International Mechanical Engineering Congress & Exposition, Hilton/Sheraton New York Hotel and Towers, New York, NY, November 11–16, 2001.

[5] *An augmented systems approach to mimetic preconditioning*. Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO, April 1–6, 2001.

[6] *An introduction to beowulf-class clusters*. Invited talk, Computer Science Department, University of British Columbia, Vancouver, BC, Canada, July 27, 1999.

[7] *Parallel multigrid homogenization on workstation clusters*. Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO, April 11–16, 1999.

[8] *Relaxation algorithms for cell- and edge-based discretizations*. Copper Mountain Conference on Iterative Methods, Copper Mountain, CO, March 30 – April 3, 1998.

[9] *Multigrid homogenization of heterogeneous porous media*. Colorado Days, University of Colorado at Boulder, Boulder, CO, April 30 – May 2, 1998.

Selected Publications

[1] M. BERNDT, K. LIPNIKOV, J. D. MOULTON, AND M. J. SHASHKOV. Convergence of mimetic finite difference discretizations of the diffusion equation. *East–West Journal of Numerical Mathematics*, 9:253–316, 2001.

[2] D. M. TARTAKOVSKY, J. D. MOULTON, AND V. A. ZLOTNIK. Kinematic structure of minipermeameter flow. *Water Resour. Res.*, 36:2433–2442, 2000.

[3] J. E. DENDY AND J. D. MOULTON. Some aspects of multigrid for mixed discretizations. In E. DICK, K. RIEMSLAGH, AND J. VIERENDEELS, editors, *Multigrid VI, Proceedings of the Sixth European Multigrid Conference, held in Gent, Belgium, September 27-30, 1999*, volume 14 of *Lecture Notes in Computational Science and Engineering*, pages 80–86. Springer–Verlag, 2000.

[4] J. D. MOULTON, S. KNAPEK, AND J. E. DENDY. Multilevel upscaling in heterogeneous porous media. Research Highlights LA-UR 99-4754, Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, NM, January 1999.

[5] J. D. MOULTON, J. E. DENDY, AND J. M. HYMAN. The black box multigrid numerical homogenization algorithm. *J. Comput. Phys.*, 141:1–29, 1998.

[6] J. D. MOULTON, J. E. MOREL, AND U. M. ASCHER. Approximate schur complement preconditioning of the lowest-order nodal discretizations. *SIAM J. Sci. Comput.*, 19(1):185–205, Jan 1998.

[7] M. S. PATTERSON, J. D. MOULTON, B. C. WILSON, K. W. BERNDT, AND J. R. LAKOWICZ. Frequency-domain reflectance for the determination of the scattering and absorption properties of tissue. *Appl. Opt.*, 30(31):4474–4476, 1991.

[8] M. S. PATTERSON, S. J. MADSEN, J. D. MOULTON, AND B. C. WILSON. Diffusion equation representation of photon migration in tissue. In G. L. HIETER, editor, *International Microwave Symposium*, volume 2, pages 905–908. IEEE MTT-S, 1991.

[9] S. J. MADSEN, M. S. PATTERSON, B. C. WILSON, Y. D. PARK, J. D. MOULTON, S. L. JACQUES, AND Y. HEFETZ. Time resolved diffuse reflectance and transmittance studies in tissue simulating phantoms: A comparison between theory and experiment. In B. CHANCE, editor, *Time Resolved Spectroscopy and Imaging of Tissues*, volume 1431, pages 42–51. SPIE, 1991.

[10] M. S. PATTERSON, J. D. MOULTON, B. C. WILSON, AND B. CHANCE. Applications of time-resolved light scattering measurements to photodynamic therapy dosimetry. In T. J. DOUGHERTY, editor, *Photodynamic Therapy Mechanisms II*, volume 1203, pages 62–75. SPIE, 1990.

[11] B. C. WILSON, M. S. PATTERSON, S. T. FLOCK, AND J. D. MOULTON. The optical absorption and scattering properties of tissues in the visible and near-infrared wavelength range. In R. H. DOUGLAS, J. MOAN, AND F. DALL'ACQUA, editors, *Light in Biology and Medicine*, volume 1, pages 45–52. Plenum Publishing Corp., 1988.